
Environmental pressures and impacts of public sector organisations: the case of the Portuguese military

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Abstract: Public institutions are beginning to realise that they must shift their management towards sustainability. Thus, public sector, including defence services, environmental performance evaluation is a growing reality. The main objective of this research was to assess the environmental pressures and impacts profile of the Portuguese defence sector. A questionnaire survey was conducted involving all Portuguese military units that have a person in charge of environmental issues. Respondents generally reported that the majority of their activities have few serious environmental problems. These results could show the respondents' general perception of the increasing implementation of environmental management practices in military units and probably some lack of knowledge, but also a standard based on compliance with regulations. Many environmental pressures in the Portuguese military are related to primary environmental problems, such as water supply, wastewater and solid waste, showing that the integration of environmental awareness and practices into the Portuguese military is quite new.

Keywords: public sector; military; environmental performance; questionnaire survey.

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1 Introduction

For many years public institutions were far removed from general environmental concerns and management practices. As stressed by the OECD (1998), government agencies are not subject to the kind of external pressures that drive change in the private

sector, or even in local government. The public sector is now beginning to realise that it must shift management towards sustainability, and thus public sector environmental performance evaluation is a growing reality.

The Organization for Economic Cooperation and Development (OECD) led the way with guidance documents such as 'Improving the environmental performance of government' (OECD, 1996) and 'Improving the environmental performance of public procurement' (OECD, 2002).

Various countries are beginning to implement 'greening government' programmes (*e.g.*, the UK's Sustainable Development in Government; 'Greening Government' in Canada; 'Greening the Government through Leadership in Environmental Management' in the USA). The implementation of environmental audits and in particular Environmental management systems (EMS) in the public sector has recently been analysed by many authors (*e.g.*, Lusser, 2001; Andrews *et al.*, 2001; Walsh, 1999; Hinds, 1999; USEPA, 1999; Diamantis, 1999; OECD, 1998; USDOE/USEPA, 1998; Swift and Broady, 1998; USEPA, 1997; Taylor, 1992). The focus of these works varies from the individual organisation to the country level (see Honkasalo, 1999), ranging from local, regional, federal/national government agencies and departments to universities (*e.g.*, Mora and Martin, 1998; Flint, 2001) and on to hospitals (*e.g.*, Dettenkofer *et al.*, 2000) and military units (*e.g.*, Drawbaugh, 1999). The OECD (1998) relates that most progress on EMS in government agencies has been made at the local level. This is due to their close, day-to-day contact with their electorate, public pressure for efficient government, and the need to demonstrate 'best value' to key stakeholders. Central governments appear to be moving more slowly.

Public sector-led strategic initiatives, such as policies, plans and programmes, play a fundamental role to improve environmental and sustainability performance. Legislation, economic instruments and voluntary schemes should be designed to be applied beyond traditional sectors, such as energy, industry or transport. Environmental assessment and management tools have been most often applied to manufacturing industries and tangible products. Public organisations usually neglect and/or omit their own environmental problems, excluding themselves from the scope of strategic initiatives. This is important, since it is understood that public organisations must respond to social needs not covered by the private sector. Like any other organisation, public services should have environmental objectives, goals and targets.

The defence sector oversees an important number of activities, products, services and facilities. While part of this activity is specifically military, such as weapons training, much is identical to civilian activity (*e.g.*, administration, transportation, building climatisation) or public service missions (*e.g.*, maritime search and rescue). Militaries throughout the world are adopting EMS and/or environmental programmes, particularly in Australia, Canada, Spain, Sweden, the UK and the USA (*e.g.*, Taylor *et al.*, 2001; US DoD, 2000; USMC, 2000; Steucke, 2000; NATO, 2000; Drawbaugh, 1999; LFC/DND/CF, 1999; Lederer, 1997).

Various defence institutions and countries have swiftly understood the role of environmental management practices in peacetime defence activities and missions. Many experiences and case studies reveal that some countries already have examples of integrating environmental tools and practices into the military sector, including the armed forces and defence administration. In wartime, the priorities are the accomplishment of military missions. However, some environmental management practices can have results

in both peacetime and wartime, such as environmental criteria in acquisition procedures or energy efficiency practices, (which entail lower greenhouse gas emissions). In addition, the difference between peacetime and wartime is becoming unclear, with several new threats and nontraditional conflicts.

On the one hand, we are already engaged in an unconventional and undeclared war on terrorism. On the other hand, today more and more peacekeeping or combat missions are carried out among civilian populations that are supposed to be protected, not harmed. For operational purposes, safety and environmental standards should be enforced as a rule, whether those missions are conducted under a declared state of war or not (Ramos and Melo, 2006). Global environmental changes (*e.g.*, climate change, biodiversity loss and health, desertification and land degradation, fresh water decline) will also require responses to these new societal problems and threats. Defence services will have several different potential roles, such as protection, mediation, control, surveillance and restoration. Environmental refugees needing protection and support are an example of how defence organisations can play an important and growing role.

The main objective of this research was to assess the Portuguese defence sector's environmental pressures and impacts profile, as the first step towards developing environmental performance indicators at the national level of defence. Another objective was to evaluate the association between the main mission/activities and environmental problems. A questionnaire survey was conducted involving Portuguese military units.

2 Typology of missions/activities and environmental pressures and impacts

Most defence sector activities are divided among the traditional military branches – the air force, army and navy. Each service performs different functions that impact the environment differently. Defence installations range in size from a few hectares to thousands of square kilometres; missions range from logistics and training to manufacturing and rebuilding aircraft and ships. Many of these installations are the equivalent of small (and sometimes not so small) cities; therefore they will have all the urban facilities (*e.g.*, hospitals, sewage treatment plants, roads, airports) with the related environmental problems. Much of the support activity associated with the defence services' mission is industrial in nature (USEPA, 1996).

Environmental 'aspects' and 'impacts' are commonly mentioned in environmental management, based on the loose definitions in the ISO 14000 family of standards or other management-specific literature. However, such terms have been present in the terminology of environmental science and engineering, particularly in the field of environmental impact assessment, for more than 30 years, with a somewhat different meaning. The result is that the terminology used in environmental management is still not well established and is often incoherent. The term 'impact' is sometimes used rather loosely to include almost any sort of environmental information. Kuhre (1998), for example, uses the terms 'aspects', 'effects' and 'impacts' interchangeably.

The terms used in this paper follow the concepts of *driving forces*, *pressures*, *state*, *impact* and *responses* presented in indicator frameworks such as the PSR framework (OECD, 1993), DPSIR framework (UNEP/RIVM, 1994; RIVM, 1995), adopted by the European Environment Agency, and PSR-E framework (USEPA, 1995). Driving forces are understood as the social needs that require the existence of a given public institution

(in this case, the military) and are stated in the overall mission of the institution. Environmental 'aspects' refer to the activities, products and services (or parts thereof) that may influence the environment and/or to specific environmental pressures such as water, materials and energy consumption, pollutant emissions, waste disposal or land use patterns. Institutional missions cover a range of activities that generate environmental pressures which, in turn, modify the state of the ecological and social environment. Accordingly, an environmental impact or effect is a measure of the change in the state of the environment, provoked by a given mission or activity and significant for human or ecosystem well-being. Undesirable impacts lead to a response from society, resulting in the formulation of an environmental policy. It must also be clarified that the term *significant* carries no statistical meaning when used with the concepts *environmental aspect* and *environmental impact*; it refers to criteria such as the importance of effects on a natural resource, or to the degree of compliance with an environmental standard or goal.

On the basis of environmental field assessments and literature (US Army, 2003; Garten *et al.*, 2003; Walker, 2002; DA, 2001; EA, 2001; 2000; US DoD, 2000; Brzoska *et al.*, 2000; Milchunas *et al.*, 2000; NATO, 1996; 2000; Whitecotton *et al.*, 2000; Schieche, 2000; DND/CF, 1997; 2000; LFC/DND/CF, 1999; Lehman *et al.*, 1999; US DoD and SAF, 1999; Resetar *et al.*, 1998; NTG, 1998; US Air Force, 1998; Doxford and Hill, 1998; Tucker *et al.*, 1998; USEPA, 1996; Trumbull *et al.*, 1994), the following typical defence activities, environmental pressures and impacts were identified (Table 1).

Table 1 Typology of main military activities, environmental pressures and impacts

Activities
Acquisition, storage and distribution activities of heavy conventional weapons (<i>e.g.</i> , military aircraft, armoured vehicles, artillery pieces, missiles and warships), light weapons (person or crew-portable weapons such as rifles and hand grenades), ammunition and other military-type goods
Military air, ground and sea traffic
Manufacturing, maintenance, repair, testing/evaluation and support activities of heavy conventional weapons, light weapons and ammunition and of small arms (<i>e.g.</i> , cleaning, coatings, composite repair, painting, de-painting, plating, bonding, sealing, and inspection and degreasing operations)
Demilitarisation (<i>e.g.</i> , conventional ammunition and missiles, artillery pieces, aircraft, ships and combat vehicles, associated spare parts and sub-assemblies, and other serviceable and unserviceable commodities)
Training activities (<i>e.g.</i> , fire fighting and artillery training, live fire exercises, mechanised infantry training, engineer training, aviation training, vehicle manoeuvres) that occur on land, in the air, or at sea, and include the deployment, use and operation of hand-held weapons and munitions, artillery pieces, tanks and other combat vehicles, conventional on-road vehicles, off-road vehicles, aircraft, amphibious vehicles and landing craft and land-launched weapons systems
Bivouac operations
Military research, concept and technology development.

Table 1 Typology of main military activities, environmental pressures and impacts (continued)

Environmental pressures

Air emissions such as ozone-depleting substances and volatile organic compounds (*e.g.*, released from the storage and transfer of petroleum fuels; degreasing operations; vehicle and building painting operations; training activities, especially vehicle manoeuvre training, firing ranges, including firing points, explosions, open burn/open detonation; waste disposal, such as incineration; dry clean operations and emergency back-up generators; automobiles, ships, aircraft, and other industrial processes associated with maintaining weapon systems)

Generation of noise, odour, radiation and vibrations (*e.g.*, from artillery firing and airfields, tactical vehicles and guns during training exercises, open burn/open detonation and firing of high explosives)

Use of ammunition (*e.g.*, munitions use in training, testing or military operations)

Use of hazardous materials (*e.g.*, synthetic lubricants, oils and fuels, paints, solvents, batteries containing lead acid, protective mask cartridges, and weapon-cleaning materials used in manufacturing, maintenance and repair of ammunition and heavy and light weapons; use of insecticides, herbicides and other pesticides)

Discharges (point and nonpoint) to soil and to ground or surface waters, such as fuel, oil or lubricant (during tactical refuelling operations, from storage tank leaks and spill releases)

Hazardous waste generation (*e.g.*, used filters for oil, cooling waste, waste solvents, oils, paints and paint sludge, munitions and related wastes used in training, testing and demilitarisation or other military operations, open burn/open detonation and unexploded ordnance wastes)

Disposal and treatment of wastes, including nonhazardous waste, such as domestic solid waste, and hazardous waste such as biohazardous and medical waste

Generation of wastewater and sludge (*e.g.*, from demilitarisation, washing of vehicles and equipment)

Consumption of water and energy (including electricity and petroleum-based and alternative fuels)

Vehicle circulation (*e.g.*, mechanised infantry training and vehicle manoeuvres)

Workforce training (environmental education and training).

Environmental impacts

Air quality deterioration

Soil erosion/degradation and contamination (*e.g.*, contamination with metals such as iron, aluminium, copper, tungsten, depleted uranium and lead; disturbance of physical soil properties and/or the soil structure is commonly associated with the use of heavy vehicles in military training)

Aesthetics and topography alterations (*e.g.*, cratering effects of high explosives and white phosphorous use)

Deterioration in surface and groundwater quality (*e.g.*, effluents from painting and washing military vehicles)

Hydrological alteration due to changes in landforms from explosions, vegetation clearance and soil compaction; increased turbidity and sedimentation in rainfall runoff are expected as a result of infrastructure development, particularly the establishment of a formed gravel road network; sedimentation of rivers due to disturbance by vehicle training

Perturbation of terrestrial and aquatic ecosystems (*e.g.*, natural resource depletion, comprising for example the removal of vegetation by tracked vehicles; disturbance of habitats, with disturbance of wildlife and endangered species, including for example nesting failures; loss of wetland, forests, woodlands and other sensitive areas that provide a habitat for wildlife; toxic effects on animals)

Cultural resource degradation, including historic properties, archaeological sites and more traditional cultural assets

Perturbation of the surrounding local communities, including quality of life degradation and human health effects (*e.g.*, hearing degradation).

Beyond the activities presented, there are a lot of nonspecific military activities, although they support the overall defence mission:

- Logistics operations: facility maintenance and repair, assembly and organisation of material and personnel resources, transportation (*e.g.*, personnel, material and hazardous wastes), acquisition, storage, distribution and recovery of all classes of supply (*e.g.*, electronic/communication systems and chemical products such as fluids, solvents, hydraulics, synthetic oils, degreasers, paints and fuel), refuelling operations, and provision of support services such as food, commissaries and laundries.
- Installation/Utility operations (*e.g.*, the operating of a water or wastewater treatment plant, power generation facility, or sanitary landfill; pest control management; the cleaning up of contaminated sites; underground and aboveground tank maintenance; hospital/medical operations; laboratory activities; and photographic and printing processes).

3 Methodology

3.1 The Portuguese military

The Portuguese defence sector is one of the largest in the public service, with many civilian employees, servicemen and servicewomen, and reservists. Like other Portuguese public services, the defence sector oversees an important number of facilities and operations, including large areas of land (23 135 hectares (MDN, 2002), or about 0.25% of the Portuguese territory).

The Ministry of Defence (MDN) oversees a vast number of organisations (*e.g.*, directorates general, public institutes and state-owned companies), plus the armed forces, divided into the three military branches: army, air force and navy (including marines), and all the related organisations (*e.g.*, bases, garrisons, agencies and commands).

The total expenditure of the Portuguese defence sector represents about 1.2% of GDP and 3.2% of public sector expenses. Manpower stands at 42 677 (for the year 2000), down from 62 300 in 1990 (MDN, 2002).

For many years national defence policy did not accept environmental issues as part of its responsibilities, although the military carried out environment-related public service missions such as marine pollution control and surveillance, and forest fire prevention. By 1995, the first environmental commitments of the MDN were assumed under the national environmental policy plan (MARN, 1995). This policy was updated in 2001 (MDN, 2001) and empowered with the publication in 2002 of the Portuguese version of the NATO Standardization Agreement (STANAG 7141 EP – 1st edition). This NATO standard was published with the aim of stating the environmental doctrine for NATO-led operations and exercises and providing guidance in environmental planning for all military activities (NATO, 2002). Several recent initiatives have been undertaken by the MDN and the military branches, revealing a rising interest in achieving better environmental performance: environmental cooperation with academic/research institutions, environmental training and the annual attribution of the national environmental and defence award to military units. Three military units already have certified EMS under ISO 14001: Campo de Tiro de Alcochete, an air force training camp;

Instituto Geográfico do Exército, the Army Survey Agency; and Campo Militar de Santa Margarida, an army training camp. Campo de Tiro de Alcochete was the first Portuguese public institution to be awarded an EMS certificate.

Portuguese defence institutions play an important role in the national context and, as stressed by Ramos and Melo (2005), if good intentions are carried out, the Portuguese military may indeed become an example for the rest of the public sector regarding better environmental management practices. However, and despite some positive signals by the Portuguese defence administration, national environmental authorities rarely involve this sector in their initiatives. For example, in the national sustainable development strategy, the national land-use plan and the national programme for climate change, the defence sector is almost ignored.

3.2 *Survey questionnaire*

The aim of the questionnaire was to evaluate the main missions and activities and the related environmental pressures and impacts of the Portuguese military sector. This survey included the armed forces and the related defence administration responsible for supporting military activities. The assessment was based on a characterisation of the missions, activities, environmental pressures and impacts of the military sector, represented by organisations of the three branches of the Portuguese armed forces. The survey is based on self-assessment by the services.

The statistical population was defined on the basis of a single criterion: it considers all the Portuguese military units that have a person in charge of environmental issues. On this basis, the entire population was surveyed. The target of this study includes bases, barracks, garrisons, agencies and commands of the Portuguese armed forces. To simplify matters, the general term 'military unit' was adopted to represent all the different kinds of military organisations encompassed by this study. According to this definition, one facility or camp may include several independent units that fulfil the criterion of having a person in charge of environmental issues.

The questionnaire was mailed in October 2003 to the 74 targeted units (Table 2) from the Office of the Portuguese Minister of Defence to the Commander-in-Chief of each military branch. The units surveyed represent about 25% of the total number of Portuguese military units (about 300), though encompassing a higher percentage of the land area and personnel. In all, 53 units returned usable responses, representing a response rate of 72%.

Table 2 Portuguese military units: total units, population and respondents

<i>Population groups</i>	<i>Total units (no.)</i>	<i>Statistical population (no.)*</i>	<i>Usable respondent units (no.)</i>	<i>Response rate (%)</i>
Military sector	300	74	53	72
Army	142	29	17	59
Air force	53	13	13	100
Navy	105	32	23	72

Note: * Military units with a person in charge of environmental issues.

The questionnaire addressed 20 questions, drawn from case studies and from scientific/technical and military literature. The questions addressing the topic covered by this work are summarised as follows:

- General description: geographic location; population; land area; main military mission
- Activities, environmental pressures and impacts: main activities; importance of environmental problems by chosen activity; environmental pressures and their significance; negative environmental impacts and their significance; factors used for significance assessments; previously existing procedures for the evaluation of pressures/impacts; a description of significant impacts.

A pretest to the questionnaire with a set of selected individuals from the military and the academic sectors was performed. The pretest was conducted to assess the overall quality of the draft questionnaire, especially designed for questionnaire clarity, comprehensiveness and acceptability (Rea and Parker, 1997).

To verify some results, follow-up telephone calls to respondents were made. The missing cases (nonresponses) were dealt with in accordance with the recommendations of Rea and Parker (1997), through the identification per response category and the estimation of adjusted frequencies. When appropriate, Chi-square was used to test associations between frequency distributions among the military branches (Wheater and Cook, 2000). Descriptive statistics were also used to analyse the results in the military units surveyed. The nonparametric test Spearman r_s correlation was performed to assess the relations between several variables.

4 Results and discussion

The total personnel (including civilians and military) of the military units range from 13 to 1297. The average number for the total sample was 324. About 37% are residents (in-housing on the unit), mostly military people. Military personnel in the overall population (residents plus nonresidents) represent 88%. This result is in accordance with previous data from the official statistics for the entire sector (MDN, 2002). The average land area occupied by a single unit is 313 hectares, with a maximum of 7500 and a minimum of 0.034. The total land area allocated to each unit (not applicable for ship-based navy units) registers great variation, ensuring that these analyses focus on small, medium and large organisations.

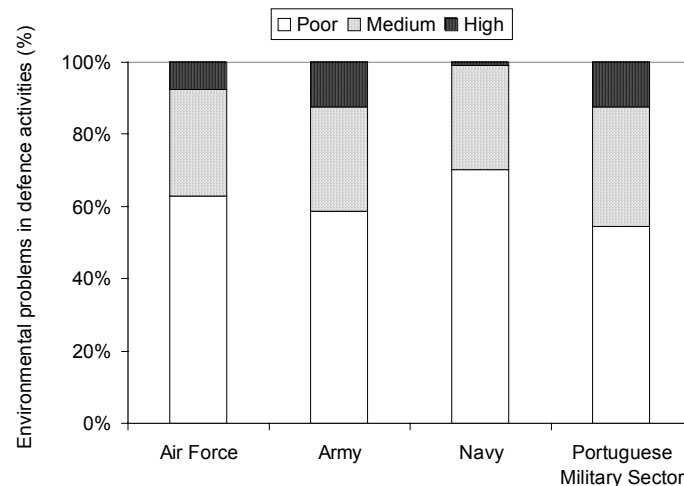
The majority of the units are located in the Lisboa e Vale do Tejo region (74%), owing to the location of military high commands in or near Lisbon, the major naval base in the Tagus estuary, and several major army and air force bases in the lower Tagus plains within a 150 km radius of Lisbon. Other than that, military units are evenly distributed throughout the country.

Primary missions are supported by 98 different activities, which could be classified as operational, training, management, general administration and logistics. There is no general activity trend for the units surveyed, which shows the expected wide range of missions and assures representativity. Nevertheless, certain missions and principal activities can be identified as having a central role, namely, territorial defence and military security, logistics, military instruction and training, inspection/surveillance,

rescue operations, general management/administration and military exercises. The general trend of a higher average number of activities for the largest units (land area and personnel) was verified. Spearman r_s correlation tests confirmed the significant relations for $p < 0.05$. However, there is no significant relation between the number of activities and the geographic location or the military branch.

The level of environmental problems related with defence activities reveals an apparently overoptimistic scenario, generally characterised by few activities with important environmental problems (Figure 1). The results by branch show that army units acknowledge that 15% of their activities have high-level environmental problems, in opposition to the 2% mentioned by the navy. These results show an apparent undervaluation of the real situation. The optimistic self-assessment may reflect a lack of knowledge, a response based on mere compliance with regulations or possibly negligence, rather than an objective assessment of environmental significance.

Figure 1 Level of environmental problems related with the defence activities



Overall results allow the identification of specific defence activities with relevant environmental problems (Table 3). Among the branches, the army presents the highest number of units identifying activities with serious environmental problems. Beyond these activities, the main nonspecific defence activities identified as involving serious environmental problems are waste management, storage operations (*e.g.*, fuels, oils and lubricants) and fuel distribution and vehicle refuelling. The specific nonmilitary activities are often classified as having medium- or high-level problems, ranging from 8% to 30% of respondents. This could be explained by their essential contribution to the daily life of the military units, which are regularly equivalent to small cities. There is no similar work available for other countries' armed forces, *i.e.*, studies that compare the environmental problems relating to the different military activities of the main military branches at a national level. However, an attempt can be made to make comparisons with other military forces. The profile obtained in this work generally matches the most typical military activities with significant environmental problems, as shown in several works, such as US Army (2003; 2001), US DoD (2000), Brzoska *et al.* (2000), NATO (1996;

2000), Schieche (2000), LFC/DND/CF (1999), Resetar *et al.* (1998), NTG (1998), US Air Force (1998), DND/CF (1997) and USEPA (1996). The similarities noted among different military forces, despite the various limitations related to the scope of the studies and the different situations in the different countries, including size, culture and military development, indicate a general pattern of core activities with major environmental problems in the military forces.

Table 3 The top ten environmentally problematic activities specifically identified by the respondent units

<i>High</i>		<i>Medium</i>	
<i>Activities</i>	<i>Respondents (%)</i>	<i>Activities</i>	<i>Respondents (%)</i>
Maintenance of transport vehicles	4	Ground units, firing exercises	15
Civil-military cooperation	2	Military manoeuvres exercises	15
Territorial defence	2	Maintenance of transport vehicles	11
Maintenance of combat vehicles	2	Naval units, firing exercises	9
Maintenance of other military equipment	2	Storage of transport vehicles	9
Military instruction and training	2	International military exercises	8
Storage of provisions	2	Military transport (air, ground and naval)	8
Storage of transport vehicles	2	Weapons tests	6
Storage of other military equipment	2	Maintenance of heavy weapons	6
–	–	Storage of combat vehicles	6

Significant and nonsignificant environmental pressures identified by the military units also show great diversity among the different respondents. Fuel consumption is chosen by the majority of military units (55%) as a significant environmental aspect (Table 4). The Spearman correlation test shows no association between the number of significant environmental pressures and a unit's size (land area and personnel), the geographic location or the military branch.

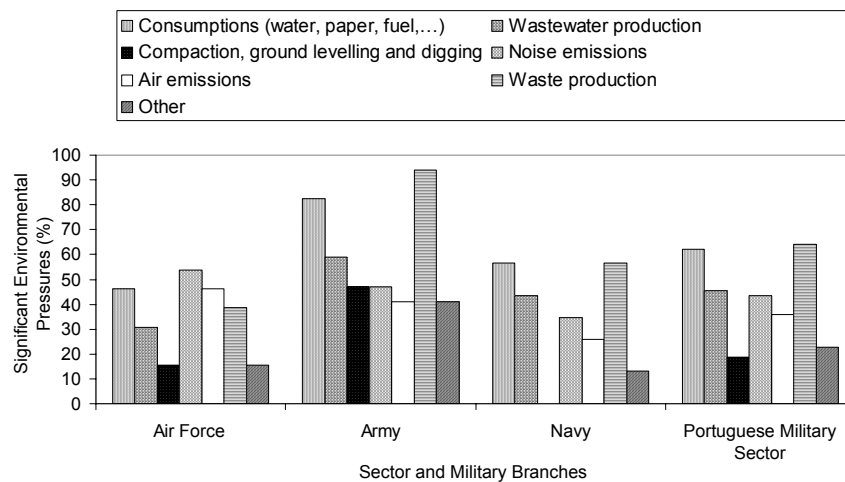
By branch, the significant environmental pressures are related with their main activities. The air force identifies noise generated by vehicles and aircraft, especially the latter indicated by 54% of respondents, followed by fuel consumption, indicated by 46%. The army presents a number of environmental pressures that were chosen by many respondents: fuel, oil and lubricant consumption, domestic waste and waste oil production, indicated by 77% of respondents per aspect mentioned. The navy also identifies fuel consumption, indicated by 44% of respondents, followed by domestic wastewater generation, domestic waste and waste oil production, all indicated by 39% of respondents. Pressures aggregated by main categories shows that in general the army identifies more significant environmental pressures than the other branches (Figure 2). Pressures related with soil and vegetation compaction, sedimentation, ground levelling

and digging related with military activities are also more important in the army. One should note that the significance classification for environmental pressures is related to the knowledge and expertise of the person in charge of environmental issues. It therefore reflects both objective effects and environmental awareness.

Table 4 The top ten significant environmental pressures identified by the respondent units

<i>Pressures</i>	<i>Respondents (%)</i>
Fuel consumption	55
Domestic waste production	51
Oil consumption/Waste oil production	49
Wastewater production	40
Paper consumption	38
Waste batteries	38
Water consumption	36
Electricity consumption	34
Printing cartridge consumption	34
Air pollution emissions produced by military vehicles	28

Figure 2 Significant environmental pressures in the defence sector and military branches identified by the respondents units

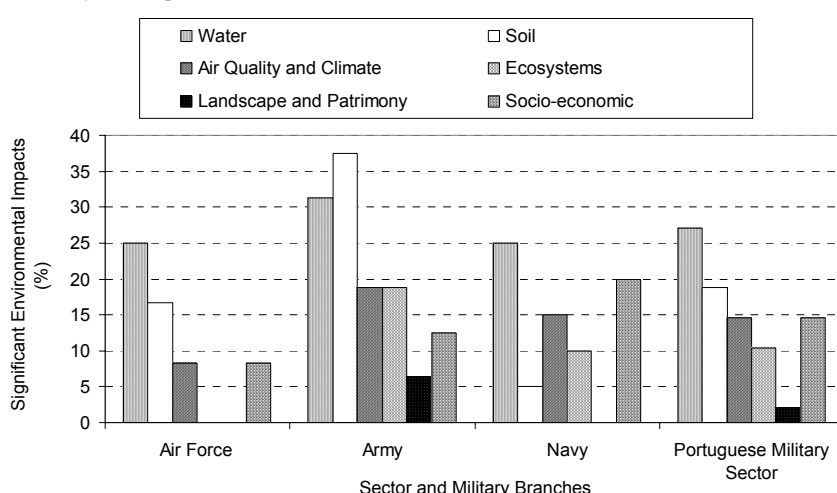


The environmental pressures identified by the Portuguese military units reflect many of the significant pressures of other armed forces, as can be verified in other work carried out in this domain, *e.g.*, US Army (2001; 2003), Walker (2002), Schieche (2000), NATO (1996; 2000), US DoD (2000), DND/CF (1997; 2000), LFC/DND/CF (1999), US DoD and SAF (1999). In particular, the main significant environmental pressures identified for the Portuguese military, such as fuel consumption or solid waste production (in particular, hazardous wastes), are frequently mentioned in other international cases. Nevertheless, in many military units (*e.g.*, Canadian or US units) the

implementation of environmental management practices is much higher than in the Portuguese military. Accordingly, many environmental pressures in the Portuguese military are related to primary environmental problems, such as water supply, wastewater and solid waste.

Negative environmental impacts show the great spectrum of defence activities. The Spearman correlation test shows no association between the number of significant environmental impacts and a unit's size (land area and personnel), geographic location or branch. The air force considered just 19% of negative impacts as significant, the navy 43% and the army 85%. Not surprisingly, the significant negative environmental impacts, aggregated by main issues, are predominantly on water in the air force and navy, and on soil in the army (Figure 3). Once again, the main significant environmental impacts identified by the Portuguese military reflect the general impacts profile of military units, as presented in several other studies, *e.g.*, Garten *et al.* (2003), US Army (2001; 2003), EA (2000; 2001), NATO (1996; 2000), Milchunas *et al.* (2000), Schieche (2000), Whitecotton *et al.* (2000), US DoD and SAF (1999), Lehman *et al.* (1999), US Air Force (1998), NTG (1998), Doxford and Hill (1998), Tucker *et al.* (1998) and Trumbull *et al.* (1994).

Figure 3 Significant environmental impacts in the defence sector and military branches identified by the respondent units



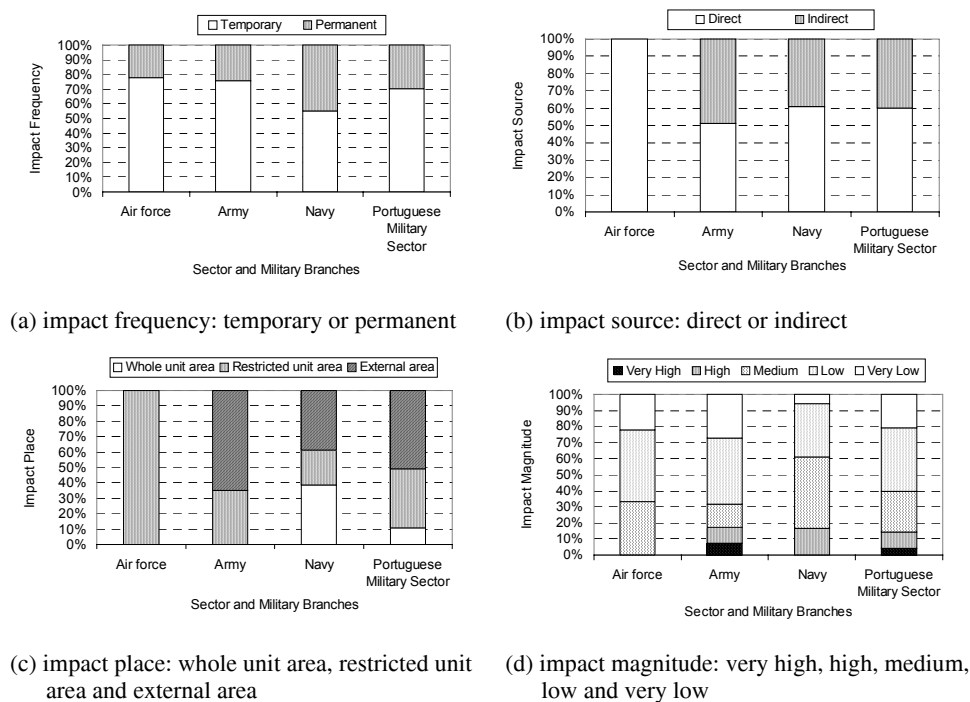
The most important significance criteria are environmental hazard/risk perception (91%), followed by safety and security at work (76%) and human health hazard/risk (67%). An important fact is that according to 24% of the respondents, the military commanders' and/or MDN staff's suggestions are the fourth main criterion for attributing aspect/impact significance.

About half of the units declare previous evaluation of environmental pressures and impacts (before this survey) (Table 5). Most of those who had performed this exercise did so as part of initial environmental reviews or impact assessment procedures. Such evaluations were usually conducted in-house, without external guidance or scientific support. The association between branches and previous identification of pressures/impacts is confirmed by the Chi-square test (significant for $p < 0.01$).

Table 5 Previous identification of environmental pressures and impacts by the respondent units (*f* = frequency)

Previous identification of environmental pressures/impacts	Air force		Army		Navy		Total	
	<i>f</i>	%	<i>f</i>	%	<i>f</i>	%	<i>f</i>	%
Yes	8	62	12	75	5	23	25	49
No	5	38	4	25	17	77	26	51
Nonresponses	0		1		1		2	
Total	13	100	16	100	22	100	51	100

The characterisation of the significant negative environmental impacts identified by the respondents with regard to four factors (Figures 4a–d) shows a significant association among branches and impact source ($p < 0.05$) and impact place ($p < 0.01$). The overall results show that in general the impacts occur outside the unit (51%), are temporary (71%), result directly from unit activities (60%), and are moderate in magnitude (40%). Magnitude classification appears to be optimistic, as with previous observations. However, no guidance was provided for the assessment of magnitude, which thus reflects the relative concern of the respondent with other issues than objective impacts (Figure 4d).

Figure 4 Characterisation of the significant environmental impacts according to the four main factors

The results obtained for the Portuguese military show a general trend of similarities with the military situation in other countries. Also, it could justify the use of environmental database management tools that will help military units in the early identification of environmental pressures and related impacts.

5 Conclusion

Assessing the environmental pressures and impacts profile of the Portuguese defence sector is an important step towards carrying out and developing environmental performance and management activities. Evaluating the relations between main missions/activities and the environmental pressures and impacts is also vital. It was for this purpose that a national survey evaluating the Portuguese defence profile was carried out. This first assessment has yielded some results about the relationship between main missions/activities and environmental pressures and impacts in military organisations.

Overall results show that defence units have a large range of missions and activities, including specific military activities and other activities similar to those required by a small town. Generally, respondents report that most of these activities have few serious environmental problems. These results could show the respondents' general perception of the increasing implementation of environmental management practices in military units. On the other hand, since the military units surveyed had a person in charge of environmental issues, some of the worst cases may have been excluded. The same can be said of the evaluation of environmental pressures and impacts carried out by the units. Nevertheless, the apparently optimistic self-assessment may reflect, in part, some lack of knowledge and also a standard based on compliance with existing regulations rather than actual environmental goals. It should be pointed out that the criterion used to define the statistical population (having a person in charge of environmental issues), although restricting the scope of the survey, was an essential prerequisite to ensure a reasonable level of response credibility.

Among the three military branches, the army has reported a profile with the greatest number of significant environmental pressures and impacts and has presented, proportionally, the most defence activities with high-level environmental problems. Certain factors could justify this different behaviour, such as:

- essentially, a poorer environmental performance than the other branches
- specific military activities that produce more environmental effects/pressures, particularly in units with heavy conventional weapons and ground-training activities
- the organisational structure of the branch, with insufficiently defined environmental responsibilities, and a larger number of units spread throughout the territory, which could lead to difficulties in managing environmental issues.

This study provided an environmental picture of the Portuguese defence sector, regarding its main missions/activities and significant environmental pressures and impacts. It must be stressed that this assessment was designed to evaluate the entire sector and not individual military units, *i.e.*, this evaluation does not rank the respondent units. For purposes of individual unit evaluation, other kinds of surveys are more appropriate, including field data collection via environmental audits.

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